



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

maintains, that "the cheyletinæ, parasites of birds, comprise the genus *Cheyletus*, *Harporhynchus*, and *Picobia*; and in regard to Heller's genus, *Syringophilus*, the same writer says, p. 236, "for these Acarina he (A. Heller) created the genus *Syringophilus* which evidently enters into the genus *Picobia*, and he has described two species in it which ought to be named *Picobia bipectinata* and *P. uncinata*." The various immature stages and the unsettled condition of this group of Acarina, together with an almost total absence of American literature has made it an unusually difficult field for students taking up this line of work. However this may be, we are thankful for the timely discussion, or I may say criticism, raised by Mr. Trouessart on my species, and the expression of his views upon a subject which he is conceded to be an eminent authority. If the form *Picobia villosa* from the black flycatcher is what he claims namely: The same as the European species above mentioned, we are pleased to have the matter straightened, also the point emphasized of the caution necessary in presenting as new, immature stages of these Acarina, sometimes so very different from the adult, and with shades of individual differences, even from localities as widely separated as Europe and America.

—DR. J. L. HANCOCK.

Chicago.

EMBRYOLOGY.¹

Conjugation in an American Crayfish.—The following observations upon the breeding habits of *Cambarus affinis* show how much difference there is between the American crayfish and the European form, *Astacus*, and serve to clear up some important structures of hitherto unknown use.

Some specimens brought from Washington, D. C., in November, 1894, immediately united in pairs when put into a shallow vessel of water. The same specimens and also others received in February paired during February, March and April. About a dozen cases were carefully observed with the following results:

In captivity the entire process of conjugation lasts from two to ten hours and may be repeated by either animal with some other.

¹ Edited by E. A. Andrews, Baltimore, Md., to whom abstracts, reviews and preliminary notes may be sent.

When a male is put into a vessel with a female he seems ere long to become aware of the presence of the female and does not act as he does when males only are present. The female generally retreats and may even resist the attacks of the male, but generally this is not done with much vigor, and very soon after being seized by the male the female passes into a state of passivity, resembling death. The male advances eagerly to the female and grasps her with his large claws, sometimes gently. When the female struggles to escape, the male holds very firmly by one of his claws that grasps a claw, or an antenna, or any projecting part of the head region of the female, and eventually succeeds in turning her upon her back; if there is no struggle, the same result is also accomplished more directly and methodically. The male now seizes all the claws of the female in his two large claws, three in each on each side and holds them firmly as seen in Figs. 1 and 2. He

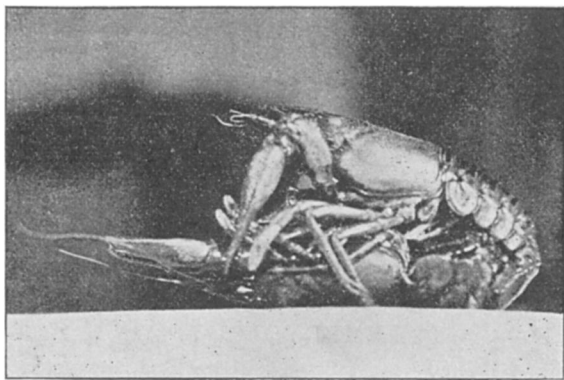


FIG. 1.

moves forward over the supine female into the position shown in the figures. This process has lasted ten to twenty minutes. It is followed by a most unexpected move: the male stands up away from the female, holding the claws as before, and deliberately passes one leg across under his body so that it projects from the opposite side. He then settles down again close to the female. The leg that is passed over is one of the fifth, most posterior, pair of walking legs. In the figures it is the left leg; it seems to be absent on the left side, Fig. 1, but projects straight out and backward between the fourth and fifth on the right side, Fig. 2. In many cases the right leg is used: in one case the leg projected between the third and fourth instead of between the fourth and fifth as usual.

This unusual position of the leg secures the proper position and direction of the intromittent organs. These are the first and second pairs of pleopodes, or abdominal appendages. They normally lie forward in a horizontal groove beneath the thorax, but now they are depressed at an angle of about 45° , and are held so by the transversely placed leg, as may be seen from Fig. 1, which shows the white tips of the intro-

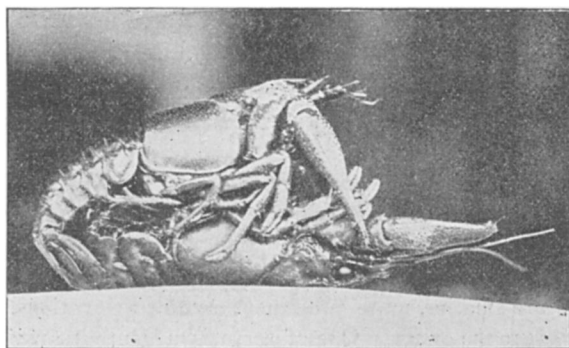


FIG. 2.

mittent organs of the left side. When the organs are thus held they may accomplish their purpose, which is to transfer the sperm to the *annulus* of the female.

As seen in Fig. 2 the abdomen of the female is bent up, and that of the male partly surrounds it. At times the male relaxes the abdomen and moves forward upon the female. Ultimately the two are so accurately adjusted—and this is a difficult problem in two such irregular, rigid masses with so many appendages—that the tips of the first pair of pleopods are thrust into the annulus.

The two are now firmly united and cannot be readily separated, in fact it was found possible to kill and preserve them in this position, and thus obtain the photographs from which the illustrations are taken. When thrown into actively boiling water for a moment, the crayfish are fixed in the normal position with no observed change, and may then be preserved indefinitely.

The firm union of the two is accomplished by the use of the hook-like spines that characterize the male of many species of *Cambarus*. In *C. affinis* there is one spine on the third segment, ischiopodite, of the third walking leg on each side of the body. When the male applies himself closely to the female, he fastens these two hooks to the base of her fourth walking legs, on each side.

The hooks depress the soft membrane between the coxopodite and basipodite on the dorsal-lateral aspect and catch firmly against the chitinous ridge formed by the hinge-like union of the chitinous edges of those same segments, coxopodite and basipodite. By this means the two animals are held together against the force necessary to introduce the male pleopods into the resistant annulus.

The animals now remain united for several hours, during which time sperm is transferred into the annulus or seminal receptacle of the female.

The annulus is a well known descriptive character found in the females of *Cambarus*, but not in *Astacus*: hitherto its use has not been known.

It varies in shape in different species.

In *C. affinis* its development varies, but in general it is a transversely elongated, ellipsoidal, chitinous elevation on the ventral side of the thorax between the bases of the fifth pair of walking legs. On this raised area are smaller, more prominent rounded elevations, bounding a transverse groove or pit. One of these is a gentle transverse ridge, forming the posterior lips of the groove; the other two are rather prominent bosses on the anterior lip of the groove.

Between these last is a longitudinal cleft on the middle line, opening posteriorly into the transverse groove, and not straight, but curved as it passes between the two bosses. Sections of this organ show that the longitudinal cleft leads into a small pouch or sac that, when seen from a dorsal view, projects upward into the body as a curved ridge. This sac has firm walls that are of calcified chitin and presents no discovered opening except the external slit. It is regarded as simply a pitting in of the chitinous exoskeleton.

After conjugation has taken place the annulus of the female has projecting from its groove a small plug of whitish substance that may remain for many weeks.

The same material fills the cavity of the sac in the annulus. It is a compact, paste-like substance forming a tubular sheath around a central axis or mass of granules that on examination prove to be the peculiar, radiated sperm-cells of the crayfish.

As the crayfish may be roughly handled and removed from one dish to another during the process of conjugation there is no difficulty in observing with a lens the means by which this sperm-plug is made. At this period of sexual excitement the terminal part of the vas deferens of the male is turned outward from the opening at the base of the fifth walking leg of each side and projects horizontally as a short, bent, con-

ical nozzle or penis-like organ. This organ fits exactly into the beginning of a long groove that extends along the first pleopod. The tip of this appendage is sharp and hard and is seen to actually penetrate into the cavity of the annulus. The sperm that issues from the vas deferens passes along the groove of the first pleopod to its tip and so into the annulus.

The second pleopod plays some part in the process of transfer, but this is known only by inference, not by direct observation. It has a peculiar triangular spoon at its end which is held applied to the first pleopod and it also has a terminal filament that fits nicely into the groove at the tip of the first pleopod. It may easily act to shove the sperm masses down along the groove of the first pleopod as well as to protect them from contact with the water and from going astray (which rarely happens.)

Apparently both sides of the body are active in this sperm transfer, but this is not certain.

The process of sperm transfer continues, with interruptions, for several hours, and then the male separates from the female. He first moves backward, and rising places the crossed leg back again into its normal position, and then releases the female.

During the entire conjugation the male is obviously excited as is shown by the vibrations of the anterior maxillipedes and by the very strong current of water cast out from the gill chamber by the exhalent apparatus. The female, on the contrary, is remarkably inert and shows no sign of any activity even in the respiratory organs. At times there is, however, a slight convulsive twitching of the base of the abdomen, possibly connected with sensations during sperm transfer.

The eye-stalks were also seen to move when disturbed by the claws of the male.

In two instances the dexterity and skill of the male were well shown after the first stages of grasping the female had been imperfectly accomplished. In these cases the male mounted upon the dorsal surface of the female and seized her claws with his, having failed to turn her over in proper sequence. In this unusual position the male attempted to adjust his appendages to the female and then became aware of the fact that the conditions were unusual. The male depressed the first antennæ so that they were firmly applied to the dorsal surface of the thorax of the female and bent forward by the pressure. The sensation so obtained seemed to initiate the almost intelligent action that followed. In one case the exopodites of the third maxillipede were also used in feeling the female. In about ten minutes the male turned the female

over and assumed the usual attitude seen in the figures and then continued the conjugation normally.

In accomplishing this feat the male first removed his left claw from the left claws of the female, and seized her rostrum and head region. By this means he turned her to lie on her left side while he was on her right. Next, the right claw let go its grasp of the female's right claws and seized her left claws. He was now able to turn her on the dorsal surface, and by then changing his left claws from the rostrum to her right claws succeeded in moving forward over her ventral surface as normally takes place. Ten minutes later sperm was passed and conjugation continued for some hours.

While there can be little doubt that the sperm so elaborately transferred to the annulus is subsequently used to fertilize the eggs as they are laid, this is, as yet, not demonstrated. One female deposited eggs in confinement towards the end of March, but these eggs did not develop, and part of the process was no doubt abnormal. This female was in a peculiarly sensitive state for four or five days prior to laying. During this time any approaching object, though ordinarily causing no reaction, would excite the female to active movements and the raising of the claws in an aggressive attitude. During this period the female most assiduously and diligently cleaned off the foreign deposits from the exoskeleton over the ventral surface of the abdomen and from the pleopods so that this region was conspicuously white.

The fifth walking legs are employed in this function, being bent back under the abdomen and rubbed against the pleopods with an unexpected amount of precision.

During this period also the female may be found at times lying on the side or on the back, and actively moving the pleopods back and forth in a rhythmic way once in about one second. The endopodites of the third maxillipedes and the chelæ and the first and second walking legs are likewise, slightly, swung back and forth.

The actual laying of the eggs took place during a night and a day. At this time a large mass of slimy material extended like a veil from the tip of the bent abdomen to the ventral side of the thorax anterior to the third walking leg. Some of the eggs were enclosed in this mass and some in a similar mass attached to the pleopods. It would seem that the eggs could pass from the oviducts under protection of this secretion to their destination on the abdominal appendages.

This mass of secreted material disappeared entirely within two days. The eggs then remained attached to the pleopods.

The sperm-plug that was present in the annulus also disappeared a day later than the secretion. As this crayfish was alone, it seems certain that she removed the sperm-plug. It remained for weeks in cases where eggs were not laid.

The eggs, however, seem not to have been fertilized: they gradually fell off and burst from osmotic changes. E. A. ANDREWS.

PSYCHOLOGY.¹

Professor Baldwin on "Mental Development."—It gives me pleasure to insert the following note which Professor Baldwin has recently sent me, with reference to the review of his book on "Mental Development in the Child and the Race," which was printed in the July number of the NATURALIST:

"The very cordial and appreciative review of my book on *Mental Development* by Dr. Newbold in the July issue of this journal contains one remark which a word from me may serve to throw light upon. Dr. Newbold says that I sometimes 'rest content with a careless and inadequate analysis of the psychoses which are to be explained.' This is no doubt just, as far as the actual contents of my book are concerned, and as far as the word 'inadequate' goes. But I may say that the inadequacy is due to the fact that I have already devoted my large *Handbook of Psychology*—especially the second volume on *Feeling and Will*—to the detailed analytic treatment of the same functions which are treated genetically in the present book. I did not feel justified in doing that a second time. And moreover many of the analytic results which my *Mental Development* assumes are, I venture to think, such common property of psychologists to day that they are largely outside the arena of debate: at least, whenever my developments in this book seemed to me to turn on points in dispute, I tried not to leave the justification of them in an inadequate state. I hope it is not too much to ask of readers that they bring their general psychology with them. It is really not the psychology that I fear the inadequacy of as much as the biology of the book, but however that may be, the omissions are well-considered and not 'careless.'"—J. MARK BALDWIN.

¹ This department is edited by Dr. Wm. Romaine Newbold, University of Pennsylvania.